

**An Application of Checkland's Soft
Systems Methodology to the
Development of a Military
Information Operations Capability
for the Australian Defence Force**

R. J. Staker

DSTO-TN-0183

19990503 040

An Application of Checkland's Soft Systems Methodology to the Development of a Military Information Operations Capability for the Australian Defence Force

R. J. Staker

**Information Technology Division
Electronics and Surveillance Research Laboratory**

DSTO-TN-0183

ABSTRACT

There is widespread concern throughout many advanced nations concerning the potential for Information Operations to influence the outcome of Military Operations. This concern is shared by elements of the Australian Defence Force and other Australian government agencies. In order to ensure that any such potential does not adversely affect Australian interests, there is a need to develop an Australian Military Information Operations capability. This document uses concepts from Checkland's Soft Systems Methodology to explore methods through which such a capability could be achieved.

APPROVED FOR PUBLIC RELEASE

DEPARTMENT OF DEFENCE
DEFENCE SCIENCE & TECHNOLOGY ORGANISATION **DSTO**

Published by

DSTO Electronics and Surveillance Research Laboratory

PO Box 1500

Salisbury, South Australia, Australia 5108

Telephone: (08) 8259 5555

Facsimile: (08) 8259 6567

© Commonwealth of Australia 1999

AR No. AR-010-816

March, 1999

APPROVED FOR PUBLIC RELEASE

An Application of Checkland's Soft Systems Methodology to the Development of a Military Information Operations Capability for the Australian Defence Force

EXECUTIVE SUMMARY

Military Information Operations focus on the decision-making aspects of warfare and operations other than war. There can be considered to be three aspects to such operations: attack, defense and support. The objective of offensive operations of this kind is to diminish an adversary commander's ability to accurately direct his forces in a timely manner, and hence to reduce his warfighting effectiveness, ideally to such an extent that he is forced to capitulate. On the other hand, the objective of defensive operations is to protect the decision-making processes of friendly commanders from such attack. Support operations are common activities required for both attack and defense.

There is widespread concern throughout many advanced nations concerning the potential for Information Operations to influence the outcome of Military Operations. This concern is shared by elements of the Australian Defence Force and other Australian government agencies. In order to ensure that any such potential does not adversely affect Australian interests, there is a need to develop an Australian Military Information Operations (MIO) capability.

However, such a capability differs from conventional capabilities in that it is a property of an organisation as a whole, rather than one which can be attributed to individual elements of an organisation. Therefore, a holistic approach must be adopted towards its development and acquisition. Systems thinking, as embodied in the discipline of systems engineering, has served a vital role in the acquisition of conventional capabilities. It is therefore to be anticipated that it would also have an important role to play in developing and acquiring an MIO capability. A difficulty is that traditional systems engineering methodologies are not holistic. They assume that a unique system can be identified with functions that can be directly allocated to the subsystems and components of which that system is composed. They are consequently unsuitable for the purposes discussed here. Fortunately, soft system methodologies offer the possibility of adopting a more holistic approach, while remaining within the broader context of systems thinking. Of these, Checkland's Soft Systems Methodology appears to be the one that is most highly developed and generally accepted.

Checkland's methodology can be applied at a highly abstract level to the study of the defence organisation, with a view to achieving an MIO capability. The object of such study is to identify and promote organisational change in directions which establish and enhance MIO capability, and, also, to provide a framework for eliciting and refining the requirements for technical means to support that capability. These requirements would subsequently be applied, within the scope of traditional systems engineering methodologies, to the acquisition of appropriate technical support products. An application of the methodology to some recent relevant developments within HQAST is provided as an example.

Contents

1	Introduction	1
2	A Review of Checkland's Methodology	2
2.1	Logical Analysis	3
2.1.1	Identifying and Defining Relevant Human Activity Systems	3
2.1.2	Constructing Conceptual Models of Systems	4
2.1.3	Reconciling Conceptual Models with Reality and Taking Action . .	9
2.2	Cultural Analyses	10
2.2.1	Analysis I	10
2.2.2	Analysis II	10
2.2.3	Analysis III	11
2.3	Action Research and Reflective Inquiry	11
2.4	Transitive Studies	12
2.5	Examples	12
3	Application of the Methodology	13
3.1	Analysis I	13
3.1.1	A Sextuplet for the Study	13
3.1.2	A Root Definition for the Study	14
3.1.3	A Conceptual Model for the Study	14
3.2	Logical Analysis	15
3.2.1	A Sextuplet for an Information Operations Staff Function	15
3.2.2	A Root Definition for an Information Operations Staff Function . .	15
3.2.3	A Conceptual Model for an Information Operations Staff Function	15
3.3	Analyses II & III	16
4	Conclusion	16
	References	16

Figures

1	Example of a Conceptual Model	5
2	Example of an IDEF0 diagram	6
3	Example of a Petri net	7
4	General Petri net for a sub-function	9
5	Problem situation roles	10

1 Introduction

Military Information Operations focus on the decision-making aspects of warfare and operations other than war. There can be considered to be three aspects to such operations: attack, defense and support. The objective of offensive operations of this kind is to diminish an adversary commander's ability to accurately direct his forces in a timely manner, and hence to reduce his warfighting effectiveness, ideally to such an extent that he is forced to capitulate. On the other hand, the objective of defensive operations is to protect the decision-making processes of friendly commanders from such attack. Support operations are common activities required for both attack and defense.

There is widespread concern throughout many advanced nations concerning the potential for Information Operations to influence the outcome of Military Operations [3, 10]. This concern is shared by elements of the Australian Defence Force and other Australian government agencies. In order to ensure that any such potential does not adversely affect Australian interests, there is a need to develop an Australian Military Information Operations capability. This document uses concepts from Checkland's Soft Systems Methodology to explore methods through which such a capability could be achieved¹.

The Total Systems Intervention approach of Flood and Jackson [6] provides a *meta*-methodology for selecting a systems analysis methodology. For systems that are complex and pluralistic, Checkland's Soft Systems Methodology [4, 5, 12] is one of the methodologies that this *meta*-methodology recommends. A *complex system* can be characterised as one which is comprised of many interacting parts such that a change affecting any one part has a propagating effect influencing all other parts in an unpredictable manner. Organisations involving interacting groups of people always have a complex nature. An organisation is *pluralistic* when groups within it have diverging interests and aspirations. The adjective "soft" is used to indicate that precise requirements cannot be defined.

Checkland's methodology also seems an appropriate choice because it has its roots in the concepts of traditional systems engineering, with which the military is conversant, from its application to the acquisition of complex military systems. Reference [2] describes traditional systems engineering in detail. It is hoped that, by adopting Soft Systems Methodology, the transition to traditional systems engineering, to support the acquisition of physical devices or other products, can be eased. These physical devices and other products would contribute to the realisation of actions that were selected through application of the soft-systems methodology.

To justify the problem situation as complex and pluralistic, consider the following. Firstly, the ADF must be regarded as a "system of systems". Some obvious examples of the systems of which it is composed are the individual service components, the Army, Air Force and Navy. There are also many other less obvious examples, but this point will not be belaboured further here. Each such system composing the overall ADF system has its own cherished traditions and culture. The introduction of a new capability may result in conflicts between these cultures. When such internecine conflicts arise, there must be

¹This Technical Note had its origins in the "Principles of Systems Engineering" course conducted by the Australian Centre for Test and Evaluation at the University of South Australia and which was held from 28th September to 2nd October 1998. It is based on the post-course assignment undertaken by the author.

some means by which an accommodation can be reached between the dissenting parties. In fortunate cases it may be possible to achieve agreement between the parties, but in the general case, the best that can be hoped for is mere accommodation and tolerance. The arbitrary imposition of a solution is most likely to lead to simmering tensions and feuding between the dissenting parties, with greatly diminished efficiency, and with a significant fraction of the effort being expended in each party undermining the efforts of other parties. Thus, a coercive system is highly undesirable.

Other indications for adopting a soft methodology are that the Information Operations environment is fluid by nature, that requirements are unclear, and that even definitions in the area are uncertain, let alone for it being possible for all parties to envisage a solution. Finally, such a capability has little precedent. All of these factors provide ample scope for a variety of opinions to be held by the various organisations that form the ADF system-of-systems and for rivalries and dissenting opinions to occur among them over aspects of the new field of Information Operations. Soft systems methodology provides a paradigm for resolving such differences.

This document has been couched in general terms, however it particularly applies to work that is being conducted in Information Warfare Studies Group in conjunction with staff at Headquarters Australian Theatre to develop an effective Information Operation capability for Theatre Operations. The work is being conducted under the auspices of task ADF 96/229.

2 A Review of Checkland's Methodology

Checkland's methodology has undergone substantial evolution during the course of its application to real-life situations over many years. The version of it that will be applied in this document is that presented by Checkland and Scholes [5]. This version of the methodology may be applied in two different modes, which Checkland simply refers to as Mode 1 and Mode 2 [5, ch 10]. Mode 1 corresponds to the case where a highlighted study is undertaken, which is the mode in which the methodology is traditionally employed. Mode 2 corresponds to the case where the methodology has been internalised by a decision-maker or decision-making organisation, and is automatically and unconsciously employed in everyday business. The mode in which the methodology is employed in this document is closer to Mode 2. This is so because the author has no direct influence on the methodologies adopted by the numerous problem solvers involved, but, rather, hopes to use Checkland's methodology to supply a framework through which, what could otherwise be a very confused situation, can be analysed. It is anticipated that the methodology will also serve to give form, substance and rigour to the author's own contributions as a problem solver. Thus, the methodology is being applied in the internalised manner of Mode 2. It may be possible that others are also inspired to adopt the methodology as a result of this report.

The methodology has several components. These are a "logical" analysis component, which identifies and analyses human activity systems, and three "cultural" analyses [5, ch 2]. These cultural analyses are referred to by Checkland as simply Analysis I, Analysis II and Analysis III. Analysis I is a consideration of the circumstances in which the study

will be conducted, and the implications of these for the manner in which it is feasible to perform the study. For example, the limitations cited in the previous paragraph provide a rudimentary form of such an analysis. Analysis II is an analysis of the social factors of the situation and Analysis III is an analysis of its political factors.

2.1 Logical Analysis

There are two main aspects to conducting the logical analysis. They are the identification and definition of human activity systems relevant to the problem situation and, subsequently, the construction of conceptual models of these activity systems.

2.1.1 Identifying and Defining Relevant Human Activity Systems

The Logical Analysis is achieved by applying logically-based thinking in which relevant human activity systems are chosen, named, modelled and compared with perceptions of the real world situation [5, ch 2]. It is performed in a consultative manner with those in a position to affect the problem situation, or to make recommendations concerning it. Often, a committee or team, drawn from the various stakeholders, is formed to oversee or participate in this part of a study.

Because of the complex, pluralistic nature of most problem situations, it is not normally possible to capture all significant aspects of the situation as a single human activity system. Instead, several must be identified. They arise from the different points of view and different aspirations of the stakeholders in the problem situation. These stakeholders are determined as a part of Analysis I of the cultural analysis, which is discussed in section 2.2.1. The stakeholders should be consulted in selecting relevant human activity systems. The relevant human activity systems can be of two types. Those corresponding to productive action are termed "primary task systems". They would relate to the mission statement of the organisation. Those that deal with the resolution of issues, and hence are more related to management of the primary tasks, are termed "issue-based systems". To be soundly based, the logical analysis should encompass systems of both types.

Checkland suggests the creation of what he terms "rich pictures" to facilitate the derivation of relevant systems. These are simple, stylised, pictorial diagrams which are intended to capture the important elements of the problem situation and to provide a common reference for all participants involved in nominating the relevant systems. Once notionally selected, the relevant systems need to be more closely defined, and this must be done in such a way that is possible to proceed with the development of conceptual models of the systems. These carefully crafted definitions are termed "root definitions" because they capture the essential character of the systems and are the roots from which the conceptual models grow.

Checkland has developed a systematic procedure for building root definitions [5, ch 2]. The first concept in building a root definition is that each relevant system should correspond to some transformation process $T : \alpha \mapsto \alpha'$ in the real world, where α represents some real-world entity and α' is a modified version of that entity. The transformation process is given implicitly by stating the affected entity and describing the modified entity.

An example that is relevant to the subject of this document could be having an original entity of "the existing defence force" and a modified entity of "a defence force with an Information Operations capability". Then, the transformation process is that entailed in introducing an Information Operations capability into a conventional defence force. In addition to the transformation induced by the system, several supplementary attributes of the system are also itemised. These facilitate and guide the construction of fruitful root definitions. They are: the set C of "customers" who are benefited or adversely affected by T ; the set A of "actors" who perform T ; the *Weltanschauung* or viewpoint W which gave rise to the system; the set O of owners who could prevent or halt the transformation process; and, the set E of environmental constraints within which the system must operate. This gives rise to the 6-tuple (C, A, T, W, O, E) . I will refer to this as the "system sextuplet", in preference to Checkland's mnemonic.

Checkland's general form for a root definition is as follows:

"a system to (insert description of transformation process T) by (describe proposed means of performing T) in order to achieve (describe the ultimate goal which the owner of the system is seeking to achieve)".

Either of the last two parts of the general form of the root definition may be omitted if no purpose is served by including them. Omitting the first of these means that the problem solver is free to choose the method of performing T . The second relates to the effectiveness of the system. Even if a system brings about the required transformation, it is not effective if it does this in a manner that is not consistent with the system owner's longer-term objectives. This last clause makes it clear what those objectives are.

2.1.2 Constructing Conceptual Models of Systems

The models on which the logical analysis is founded are constructed by identifying the functions that would need to be performed to bring about the transformation T . These functions may be contingent on the performance of yet further functions, and so these supporting functions must also be included in the model. The contingency relationships between the functions are indicated by lines with arrow-heads leading from a given function to the other functions that are contingent on it. The process of identifying supporting functions is iterated until all required functions have been identified. Loops indicate that several instances of the group of functions included within the loop may occur. In addition to the primary functions and all of the supporting functions, several further functions are added. These are functions to define measures of effectiveness, to monitor the performance of the other functions against these measures, and to take corrective action as required. By this means, a closed-loop system model, capable of regulating its own performance in a potentially changing environment, is created. An example of such a model appears in figure 1.

While the methodology itself is "soft", meaning that it can accommodate imprecision, uncertainty and alternative points of view, the conceptual models are abstract entities which may be subjected to rigorous analysis. Usually, the conceptual models are simple enough that rigorous analysis would not be warranted. However, if the methodology is to be used seriously in Information Operations applications, it is likely that complex conceptual models would arise and that some means of automatically checking that the models

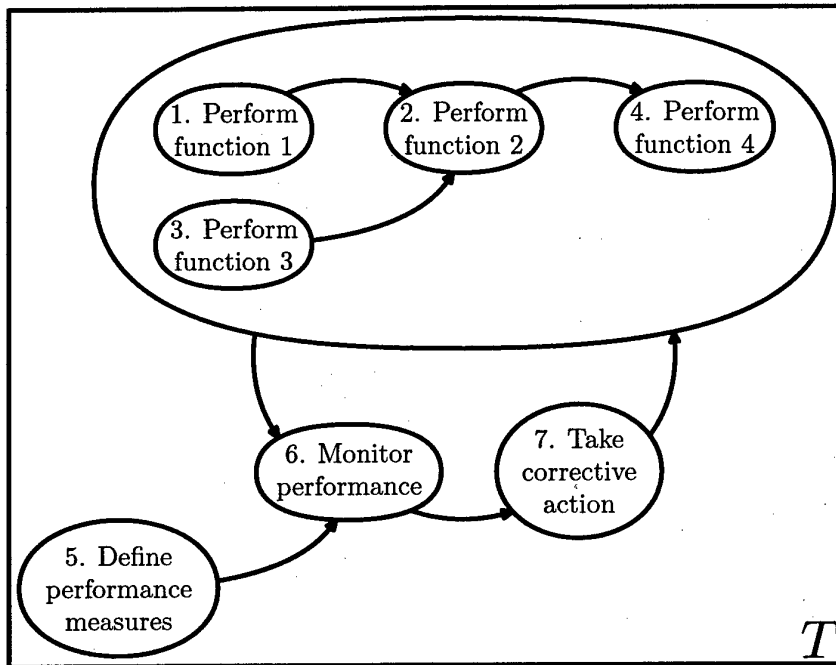


Figure 1: Example of a Conceptual Model

were internally consistent and well-behaved would become desirable. These considerations provide the rationale for now briefly examining some possibilities for more formally representing conceptual models.

Mathematically, $T = f_1 \circ \dots \circ f_n$, where the open circle denotes the composition of the functions. Contingency of a function on a second function might be expressed mathematically as $f_2 \succ f_1$. The symbol is intended to suggest the domination of the domain of f_1 by that of f_2 . The functions must be applied in a sequence that is consistent with the ordering induced by \succ , with the “largest” functions being applied first. Let all functions be regarded as being contingent on the null function ϕ which represents “inaction”. Then the set of these functions, together with the relation \succ , forms a lattice. The expression $f_1 \vee f_2$ is used to denote the least upper bound or *join* of f_1 and f_2 , while $f_1 \wedge f_2$ denotes their greatest lower bound or *meet*. The join operation corresponds to the concatenation of functions in Checkland’s diagrams. The meet operation would correspond to alternatives, if they were present. However, his diagrams do not appear to allow the possibility of alternatives. Some other more formal graphical representations that might replace or supplement Checkland’s diagrams are IDEF0 diagrams, [11], or Coloured Petri Nets, [8]. These would offer richer models that could explicitly address resource and other issues, and thereby permit some degree of automatic feasibility checking.

For example, figure 2 shows an IDEF0 diagram for the same conceptual model as before. The IDEF0 diagram is more informative in that it distinguishes between control flows and information or material flows. The control flows enter through the tops of the function boxes, while information or material flows enter and leave the sides of the function boxes. It also explicitly shows the resources required to perform each function. The required

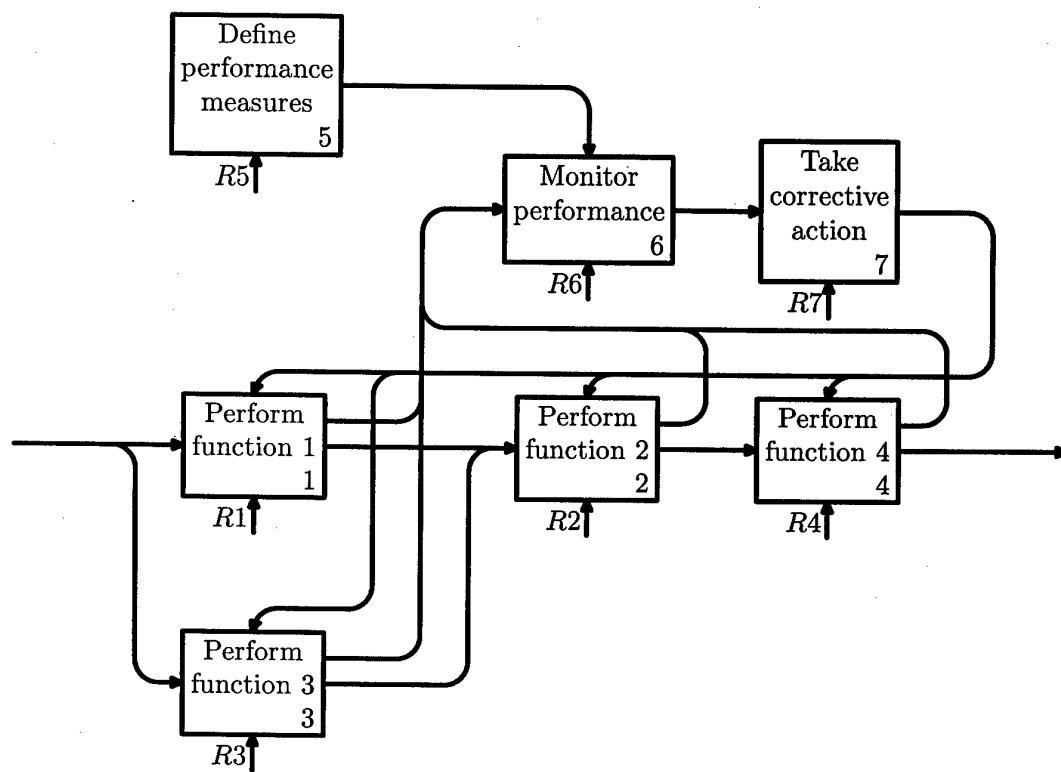


Figure 2: Example of an IDEF0 diagram

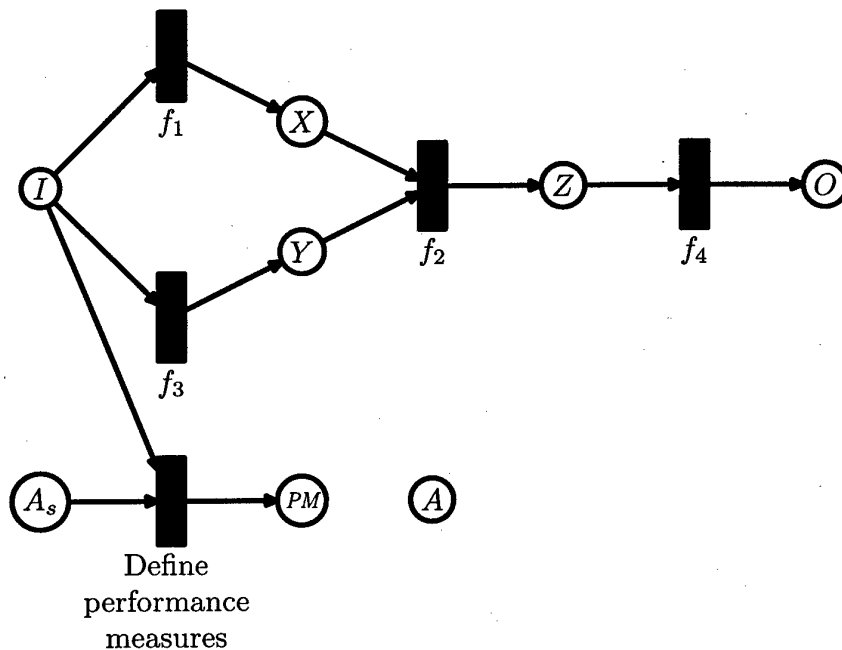


Figure 3: Example of a Petri net

resources are shown as entering the function boxes through the bottom. In this case, the material flow is the abstract one of the state of the problem situation. The resources are the actors involved. Each of the R_i in the figure will correspond to one or more actors, and any actor may be required for several functions. Where several functions depend on the same actor, the functions concerned cannot be performed simultaneously. The state and control flows also impose additional constraints on the order in which the functions may be performed. In addition to providing this extra detail, IDEF0 diagrams are valuable because they provide a standardised graphical notation for functional modeling.

While the IDEF0 diagram is more specific than the original conceptual model, still further detail can be exhibited by using a Petri net. Figure 3 shows a Petri net corresponding to the conceptual model. The circular nodes are *places* which can be occupied by *tokens*. Multiple tokens may occupy a single place. Conventional Petri nets have tokens that are all of the same kind. Coloured Petri nets are an extension of conventional Petri nets in which there may be several different token types. The name originates from imagining these different token types to be of different colours, whereas conventional Petri nets have all black tokens. The vertical rectangles are *transitions*. *Arcs* connect input places to transitions and transitions to output places. Transitions may *fire* when all the input places of that transition contain tokens of suitable types. I will refer to the tokens which allow a transition to fire as *participating tokens*. As a result of the transition firing, the participating input tokens are consumed and further tokens may be generated in the output places of the transition. The final part of a Petri net specification is the *initial marking* for the places. This specifies which tokens each place should contain initially. The initial marking has not been shown, but some details of it are discussed below. Different initial markings will be appropriate, depending on the number of actors available

to perform the tasks.

The transitions f_1 , f_2 , f_3 and f_4 correspond to the functions with the same names in the conceptual model. The figure shows several nodes, A_s , PM and A , at the bottom of the diagram that are somewhat isolated from the rest of the diagram. This is so because these are inputs to all of the remaining transitions. The connections are simply not shown for the sake of clarity. The place I is the input to the model. In the initial marking, it contains three tokens of different types, representing the two different aspects of the problem situation that are addressed by f_1 and f_2 as well as the need to generate performance measures. Instead of having different token types, three separate places might have been used for the inputs to the three transitions, but this would make the diagram less clear than one having a single input place. The places A_s and A contain tokens representing the actors. In this case, separate places have been used for "supervisor" actors, A_s , and ordinary actors, A . A single place with two different actor token types could have been used instead, but the meaning of the diagram is clearer if two different places are used. The place PM contains tokens representing performance measure tokens. The places X , Y and Z contain tokens representing various stages of completion of the transformation that is performed by the system. The place O contains tokens representing the completion of the transformation.

Figure 3 is actually intended to be a high-level Petri net, with each of the transitions f_1 , f_2 , f_3 and f_4 , within it corresponding to subsidiary Petri nets which model the functions in question. Figure 4 shows the general Petri net for one of these four functions. The shadowed places correspond to places in the high-level net. The other places are local to the subsidiary net, as are all of the transitions. The places A_s , PM and A refer to the places of the same name in the high-level Petri net. The places I_n and O_n are the input and output places of the subsidiary net and correspond to the input and output places of the high-level net transition which the subsidiary net represents. In the case of f_3 , there are actually two input places. Therefore, I_2 should be interpreted as referring to both of these places. The place PI contains performance information tokens, CA contains corrective action tokens, U contains tokens that represent the problem situation with the function f_n partially completed, and F contains such tokens with the function f_n completed. Firing of the f_n -step transition produces a PI token and either a U token or a F token. The initial marking has a token in the CA place, to enable the transition to fire the first time. The diagram shows that an actor token is seized when the function is commenced and released when the function is completed. It also shows that a "supervisor" actor is required from time to time, as the function is performed, to analyse performance information and to generate corrective actions. Performance measures are required in order to be able to analyse the performance information.

Coloured Petri nets are a particularly useful representation because sophisticated automatic analysis tools, such as *Design/CPN*, [9], are readily available for these. For simple models, such as the example used here, the use of Petri net modeling would clearly be excessive. However, for complex models, Petri net modeling is likely to be useful in determining whether adequate resources are provided and whether dead-locks or other undesirable behaviours are inherent in the model. Such complex models might arise from applications of the methodology such as that alluded to at the conclusion of this document.

Several additional representations for conceptual models have been presented in this

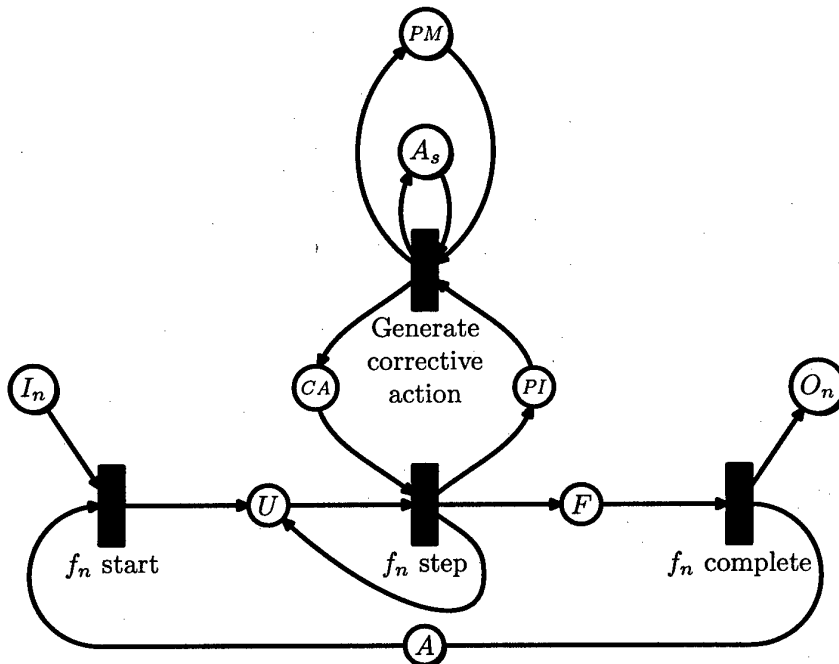


Figure 4: General Petri net for a sub-function

section that go beyond the one favoured by Checkland. Another possible representation, that is mentioned by Checkland in reference [5, ch 7], but that is not discussed further here, is that of “signal flow” diagrams. The extent to which any of these representations is appropriate will depend on the level of sophistication of the users, the level of detail which it is desired to exhibit, and the degree of analysis that is required. The mathematical notation that was introduced earlier will be used in the remainder of this document. This eliminates the need to produce several diagrams like figure 1. The greater sophistication of IDEF0 and Petri net representations is not required for this document. While the use of mathematical notation deviates markedly from Checkland’s method of free-hand diagram drawing, it seems a more convenient method for signifying contingency in a document such as this one. The greater ease of interpretation that would be provided by a diagram is less necessary here than it would be when interacting directly with study participants.

2.1.3 Reconciling Conceptual Models with Reality and Taking Action

Once a conceptual model has been created, the activities that are contained in it, the functions, can be compared with those that are perceived in the real world. If a function has no corresponding activity in the real world, then it is reasonable for the participants in the study to ponder whether the real-world situation could be improved through the introduction of this new activity. If a corresponding activity already does exist, then it is reasonable to consider whether the means by which it is performed can be improved, or whether its efficiency can be increased, and whether such action would improve the real-world situation. Proposals for changes that result from these considerations are considered

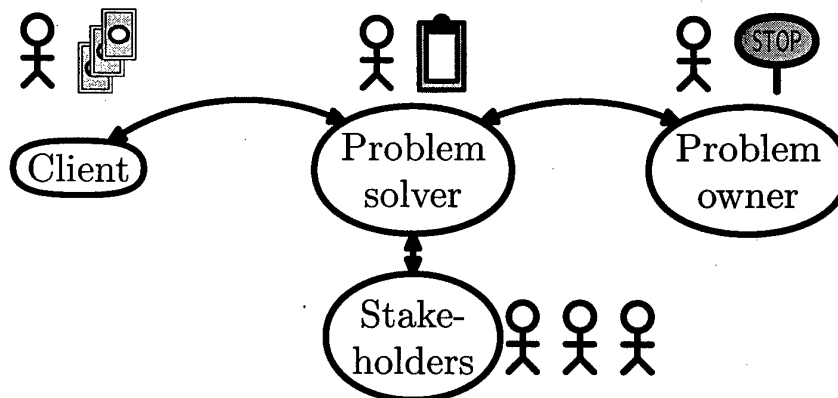


Figure 5: Problem situation roles

to “systemically desirable”. Such proposals must then be examined in the light of the cultural analysis described in section 2.2 in order to establish whether they are culturally feasible. If so, action may be taken to implement or recommend them.

2.2 Cultural Analyses

As discussed earlier, Checkland’s methodology entails the conduct of a cultural analysis concurrently with the logical analysis of the problem situation. The three aspects of this analysis are discussed below.

2.2.1 Analysis I

Analysis I is also termed the “Analysis of the Intervention” [5, ch 2]. This analysis is an analysis of the intervention in the problem situation as a problem in itself. The intervention is modelled as comprising three roles, those of “client”, “putative problem-solver” and “problem owner” or “stakeholder”. These roles are shown diagrammatically in figure 5. The client is the person or persons who caused the study to take place. The “problem-solver” seeks to achieve beneficial change in the problem situation. The stakeholders are those on whom the intervention impacts and who may be benefited or adversely affected by it. The problem solver must decide whom to regard as possible stakeholders in the analysis.

2.2.2 Analysis II

This is a “social systems” analysis, which uses a simple model to guide the analysis [5, ch 2]. The model assumes a social system to be a continually changing interaction between “roles”, “norms” and “values”. In this terminology, a role is a social position that is recognised as significant by the people in the problem situation. In the civilian context, such roles might be “manager” or “sales person”. In a military context, roles might be “commander” or “intelligence officer”. In addition, roles may exist that are not

formally designated ones in the organisational structure, but which, notwithstanding this, are recognised by those involved in the problem situation. An example of such a role might be that of "mentor".

A role is characterised by the behaviours that are expected of the person exercising that role. These expected behaviours are termed "norms". Their performance is measured against a set of "values" which represent the beliefs held by the organisation as to what constitutes good performance in the role. These values will usually be local to the organisation concerned. An important feature is that the roles, norms and values are never considered to be static, and it is assumed that they may alter in the course of the study. To accommodate this dynamic nature, the social system analysis is updated throughout the study.

Unlike some other aspects of the study, it is not generally possible to perform the social analysis by direct means. According to Checkland, direct questioning in this area is likely to lead to answers that reflect the official view of the situation, rather than the one that truly prevails. Instead, this analysis is incrementally assembled and documented by the study team as a result of what is implicitly learned from the other investigative activities.

2.2.3 Analysis III

This is a "political system" analysis, which is, again, based on a simple model [5, ch 2]. In this context, "politics" refers to the process by which differing interests reach accommodation in an organisation. The resulting accommodations ultimately rest upon the disposition of power within the organisation. The analytical technique that is employed is to examine how power is expressed in the situation under study. In order to address this, the "commodities of power" are first identified. Then, further investigation is undertaken into how these commodities are acquired, utilised, protected, preserved, transferred and relinquished. Examples of such commodities are the formal authorities associated with particular roles within the organisation, intellectual authority, and authority arising from reputation or special expertise. The political analysis enriches and rounds out the cultural appreciation previously obtained through Analyses I and II. The overall cultural appreciation obtained through all three analyses is used to underpin the logical analysis process that was described earlier. The logical analysis and cultural analysis proceed concurrently during the study and each informs the other. Sensitivity attaches to the political analysis and it is therefore not usually appropriate to publicly disclose this aspect of the study. Its role is solely to provide background information for the other parts of the study.

2.3 Action Research and Reflective Inquiry

The key objective of Checkland's methodology is to achieve beneficial action that results in an improvement in the problem situation, not merely to passively observe the situation [5, ch 1, 2]. Another important point is that it is intended that the methodology should be applied iteratively, with each iteration leading to certain actions being undertaken which then result in a modified problem situation. The analysis is then revised in the light of this new problem situation to suggest additional actions that could lead to yet further improvement [5, ch 1, 2]. Of course, if the study is a Mode 1 application of

the methodology, it must terminate at some point. The choice of this termination point is somewhat arbitrary. The iterative cycle can be regarded "action research" because it consists of research conducted within a problem situation in order to gain knowledge of it, as well as to take action to improve it.

Checkland identifies a further cycle in the study process, this time one between the construction of models and the gathering of information. As additional, more detailed and highly developed models of the relevant systems are constructed, further avenues of inquiry which to pursue in order to gain refined understanding of the problem situation are suggested. I will refer to this cycle as "reflective inquiry", for want of a better term. Checkland [5, ch 10] envisages the two cycles as intertwining strands leading to improved problem situation understanding, and more effective action being undertaken, as time progresses.

2.4 Transitive Studies

Often, the problem situation at hand entails improving the problem situation of a third party. For example, the problem situation might be to assist a service organisation to improve its service to its clients, so that they may be better able to serve their clients in turn. I will adopt the term "transitive study" for such a situation. This provides a further dimension within which to conceptualise the methodology. Checkland [5, ch 9] describes how this transitive mode of investigation arose in the context of a study that was undertaken for the Shell group of companies. This study concerned the "Manufacturing Function" of Shell, which was a unit within the company group that was composed of scientific and engineering experts. These experts undertook research and development activities and also provided technical advice to Shell production facilities, when the need arose. This assisted the production facilities to provide a high quality service to their clients.

This transitive viewpoint is relevant to Analysis I, the "analysis of the intervention itself", for the case being considered in this document. Here studies are being conducted by various headquarters' staffs in the ADF, with the assistance of DSTO, in order to provide the headquarters' commanders with an effective Information Operations capability. It is also appropriate to the hypothetical Information Operations Staff Function postulated in section 3.2. In that case the service providers are the Information Operations staffs, the service recipients are the other headquarters' staffs, and the service recipients' customers are the headquarters' commanders.

2.5 Examples

A number of detailed examples of the application of Soft Systems Methodology are given in reference [5]. The purposes of the studies described there relate primarily to generating proposals for organisational change. Wilson, [12, ch 6], gives several examples of the application of the methodology to determining requirements for information processing systems.

While soft systems methodologies other than Checkland's exist, Checkland's methodology appears to be the one that is most well developed and which has been most widely applied. Few of the other methodologies are so suited to the pluralistic character of most organisations. For example, reference [7] describes a case in the United Kingdom where the investigator at first attempted to apply a methodology based on Beer's Viable System Model, [1], to a problem situation concerning the command and control arrangements of the North Yorkshire Police Force. This initial attempt failed to produce acceptable proposals because the cultural, political and consultative aspects that are stressed in Checkland's methodology had been overlooked. In a second attempt, Checkland's methodology was adopted instead, and, although the proposals that were arrived at were much the same, the process of applying the methodology had so influenced perceptions within the organisation that these proposals had come to be viewed as very sound and reasonable.

3 Application of the Methodology

This section applies Checkland's methodology to the problem of acquiring a Military Information Operations capability. Note that a full cycle of the methodology is embedded within Analysis I, which is the analysis of the intervention itself. This analysis forms part of an exterior methodological cycle addressing the problem situation in question.

3.1 Analysis I

The analysis described in this section is an application of a full cycle of the methodology to a preliminary study of the way in which the study itself will be conducted. It is not always necessary for Analysis I to be performed in such a detailed fashion as is done here, however it is appropriate to do so in this case.

3.1.1 A Sextuplet for the Study

As discussed earlier the Customers for the "study" are the HQ commanders. This is so because it is they who authorise the expenditure of the resources required for a study and it is they who must approve any proposals recommended by it before they may be implemented. The Actors are the various working groups within the ADF, who, together with DSTO, are seeking to develop an Information Operations capability for the ADF. The desired transformation is that from a conventional defence force to one that possesses an effective Information Operations capability. The *Weltanschauung* is that "a Military Information Operations capability can enable a nation to better defend itself". The Owners are also the HQ commanders because it is they who set the limitations under which a study must operate. The Environment could perhaps be taken to be "a small, moderately wealthy, technologically advanced nation".

Note that this is the simplest case, with the customer and the owner being one and the same. If they are different, additional complications may arise because, while the customer clearly has an interest in the success of the study, the owner may be indifferent to its success.

3.1.2 A Root Definition for the Study

An appropriate Root Definition for the study itself might be:

"a system to provide the ADF HQ commanders with the capability to conduct Military Information Operations, by implicit use of Checkland's Soft Systems Methodology, in order to achieve enhanced protection of Australia's national interests within the constrained resources of the ADF".

3.1.3 A Conceptual Model for the Study

Various conferences and meetings concerning Military Information Operations have already taken place. Minutes for some of those relating specifically to HQAST may be found in ESRL registry file N 8316/21/5. From these, the author has identified the following activities as being required to develop such a capability.

1. Perform a Definitions and Interfaces Study.
2. Perform a Legality and Security Study.
3. Perform a Current Situation Study.
4. Perform a Doctrine, Organisation, Procedures and Tools Study.
5. Perform a Threat, Vulnerability and Risk Study.
6. Perform an Education, Training and Exercise Study.
7. Conduct an Advocacy Activity.

These can be readily mapped onto Checkland's framework for performing a study. Activities 1, 2 and 3 concern "finding-out" about the problem situation. Activity 4 will entail, at least implicitly, the construction of root definitions and conceptual models. A first attempt at the construction of one such model is described below in section 4.2. Comparing the conceptual models of activity 4 with the perceived real-world situation as determined by activity 3 will result in a list of systemically desirable actions to achieve an effective Information Operations capability. Activities 5 and 6 will yield further systemically desirable actions. The implementation of the systemically desirable activities will be limited by their cultural feasibility. Activity 7 seeks to improve the cultural feasibility of these actions by imbuing the culture of the organisation with an appreciation of their potential usefulness. The contingency relationships between the activities would seem to be: $\phi \succ 1$, $1 \succ 2$, $1 \succ 3$, $2 \succ 4$, $1 \succ 5$, $4 \succ 6$ and $\phi \succ 7$.

Following Checkland's paradigm, it is necessary to add to this basic set of functional activities further activities to define the criteria for efficacy, efficiency and effectiveness, to monitor the study process in accordance with these criteria, and to take remedial action if performance is unsatisfactory. These were not included as part of the original considerations.

One of the systems that it might be anticipated this study would identify as relevant to the problem situation is an Information Operations staff. The following sections discuss the application of Checkland's methodology to this hypothetical system.

3.2 Logical Analysis

3.2.1 A Sextuplet for an Information Operations Staff Function

For this case, as before, the Customer is the HQ commander. The Actors are the Information Operations Staff in cooperation with the other HQ staffs. The transformation is from an organisation with a need to produce plans and take actions that adhere to Information Operations doctrine to one with that need met. The *Weltanschauung* is that it is necessary to ensure that Information Operations doctrine is incorporated into plans and actions, in order to achieve and enhance decision-making superiority. The Owner is the commander. The Environment is the campaign within which the operation takes place.

3.2.2 A Root Definition for an Information Operations Staff Function

An appropriate root definition for the primary function performed by an Information Operations Staff might be:

"a system to ensure that a headquarters' plans and actions are consistent with Information Operations doctrine, by collaborating with the other headquarters' staffs in the production of plans and conduct of actions, in order to achieve enhanced decision-making throughout the campaign".

We could construct further root definitions for various subsidiary activities that might be performed by such a staff, such as liaison on improving Information Operations doctrine and advocacy of Information Operations concepts within the HQ. However, this would seem superfluous at this stage.

3.2.3 A Conceptual Model for an Information Operations Staff Function

The following activities can be suggested for this system.

1. Appreciate the other headquarters' staffs needs for Information Operations support.
2. Acquire and maintain special expertise in the field of Information Operations.
3. Maintain awareness of the benefits of Information Operations by those within the HQ.
4. Supply Information Operations support to the other headquarters' staffs.
5. Resolve conflicting demands placed on Information Operations staff resources.
6. Monitor and analyse the performance of the HQ in Information Operations terms.
7. Liaise with external authorities on the improvement of Information Operations doctrine.
8. Report performance and issues to the commander.

Additional functions are required to define criteria for the efficacy, efficiency and effectiveness of the functions listed above, to monitor their performance, and to take corrective action if required. The contingencies between the activities would be $\phi \succ 1$, $\phi \succ 2$, $2 \succ 3$, $2 \succ 4$, $1 \succ 5$, $2 \succ 6$, $6 \succ 7$ and $\phi \succ 8$.

3.3 Analyses II & III

The author has made some private notes concerning the cultures of the organisations involved. It is not appropriate to include those here. Being a military situation, the principal commodities of power are military rank and organisational position. However, reputation, force of personality, and intellectual authority, have all also been observed to play a role in the political situation.

4 Conclusion

This document has examined how Checkland's Soft Systems Methodology might be applied to the problem of acquiring an effective Information Operations capability for the ADF. The results of some previously existing efforts are reformulated, following Checkland's precepts, in the hope of achieving greater insight into the problem situation, and with the aim of identifying actions which could improve it. This has led to the identification of a weakness in the Information Operations study concerned, in that activities to define measures of efficacy, efficiency and effectiveness had not originally been included. Nor had related activities of monitoring performance against these measures, and of taking corrective action, been explicitly included. One action that the methodology would suggest would be to ensure that these activities are included in the study process, if this can be demonstrated to be culturally feasible.

A second application of the methodology was made to the hypothetical example of an Information Operations staff function. Here it has been demonstrated that some useful progress towards developing such a function could be achieved from a simple application of the methodology, without the need to delve into the technical details surrounding Information Operations. A third application which suggests itself, but which has not been discussed in this document, could be the application of a modified form of soft systems methodology to the Information Battle itself. Checkland mentions the possible application of Soft Systems Methodology to a conflict situation in reference [4, ch 8]. His example relates to conflict between a striking group of workers and management.

References

1. Beer, S. (1985) *Diagnosing the System for Organisations*, Wiley, Chichester.
2. Blanchard, B. S. (1998) *Systems Engineering and Analysis*, 3rd edn, Prentice-Hall International, Inc.

3. Cebrowski, A. K. (1996) *Information Warfare: Legal, Regulatory, Policy and Organizational Considerations for Assurance*, 2nd edn, The Joint Staff, United States Department of Defense, Washington D.C., 20318-6000, USA.
4. Checkland, P. (1981) *Systems Thinking, Systems Practice*, John Wiley & Sons.
5. Checkland, P. (1990) *Soft Systems Methodology in Action*, John Wiley & Sons.
6. Flood, R. L. (1991) *Creative Problem Solving*, John Wiley & Sons.
7. Jackson, M. C. (1997) Critical systems thinking and information systems development, in D. J. Sutton, ed., 'Eighth Australasian Conference on Information Systems', The Australian Computer Society.
8. Jensen, K. (1997) *Coloured Petri Nets*, Vol. 1, 2nd edn, Springer Verlag.
9. Meta Software Corporation (1993) *Design/CPN Reference Manual for X-Windows*, version 2.0 edn.
10. United States Department of Defense (1996) 'Report of the Defense Science Board task force on information warfare defense'.
11. US National Institute of Standards and Technology (1993) *FIPSPUB183 Integration Definition for Function Modeling*, US Department of Commerce.
12. Wilson, B. (1992) *Systems: Concepts, Methodologies and Applications*, 2nd edn, John Wiley & Sons.

DISTRIBUTION LIST

DSTO-TN-0183

An Application of Checkland's Soft Systems Methodology to the Development of a
Military Information Operations Capability for the Australian Defence Force

R. J. Staker

Number of Copies

DEFENCE ORGANISATION

Task Sponsor

Director General Information Strategic Concepts, M-SB-43, Department of Defence, Canberra ACT 2600	1
--	---

S&T Program

Chief Defence Scientist	}	1
FAS Science Policy		
AS Science Corporate Management		
Director General Science Policy Development		1
Counsellor, Defence Science, London		Doc Control Sheet
Counsellor, Defence Science, Washington		Doc Control Sheet
Director General Scientific Advisers and Trials	}	1
Scientific Adviser Policy and Command		
Navy Scientific Adviser		Doc Control Sheet
Scientific Adviser, Army		Doc Control Sheet
Air Force Scientific Adviser		1
Director Trials		1

Aeronautical and Maritime Research Laboratory

Director, Aeronautical and Maritime Research Laboratory	1
---	---

Electronics and Surveillance Research Laboratory

Director, Electronics and Surveillance Research Laboratory	1
Chief, Communications Division	1
Chief, Information Technology Division	1
Research Leader, Command & Control and Intelligence Systems	1
Research Leader, Command, Control and Communications	1
Research Leader, Military Computing Systems	1
Head, Advanced Computer Capabilities Group	Doc Control Sheet
Head, Information Warfare Studies Group	1
Head, Software Systems Engineering Group	Doc Control Sheet
Head, Year 2000 Project	Doc Control Sheet
Head, Systems Simulation and Assessment Group	Doc Control Sheet
Head, Trusted Computer Systems Group	Doc Control Sheet

Head, C3I Operational Analysis Group	Doc Control Sheet
Head, Information Management and Fusion Group	1
Head, Human Systems Integration Group	Doc Control Sheet
Head, C2 Australian Theatre	1
Head, Information Architectures Group	1
Head, Distributed Systems Group	Doc Control Sheet
Head, C3I Systems Concepts Group	1
Head, Organisational Change Group	Doc Control Sheet
Task Manager, Mr J. G. Schapel	1
Author, Mr R. J. Staker	4
Publications and Publicity Officer, ITD	1
DSTO Libraries	
Library Fishermens Bend	1
Library Maribyrnong	1
Library Salisbury	2
Australian Archives	1
Library, MOD, Pyrmont	Doc Control Sheet
Strategic Policy and Plans Division	
Director General Capability Analysis, R1-5-A054, Department of Defence, Canberra ACT 2600	1
Capability Development Division	
Director General Aerospace Development	Doc Control Sheet
Director General Maritime Development	Doc Control Sheet
Director General Land Development	Doc Control Sheet
Director General C3I Development	Doc Control Sheet
Headquarters Australian Theatre	
J5, HQAST, 14-18 Wylde Street, Potts Point NSW 2011	1
J6, HQAST, 14-18 Wylde Street, Potts Point NSW 2011	1
COMD ASTJIC, HQAST, 14-18 Wylde Street, Potts Point NSW 2011	1
Navy	
SO(Science), Director of Naval Warfare, Maritime Headquarters Annex, Garden Island	Doc Control Sheet
Air Force	
Headquarters Air Command (<i>for DIW-A</i>), RAAF Base, Glenbrook NSW 2773	1

Intelligence Program

DGSTA, Defence Intelligence Organisation 1

Defence Information Systems Group

Director General Corporate Information Policy and Plans, NCC-
B12-WS28, Department of Defence, Canberra ACT 2600 1

Finance and Inspector-General Program

Assistant Secretary Security (*for Director of Security - Technical*), K-3-60, Department of Defence, Canberra ACT 2600 1

Corporate Support Program (libraries)

Officer in Charge, TRS, Defence Regional Library, Canberra 1

Additional copies for DEC for exchange agreements

US Defense Technical Information Center 2

UK Defence Research Information Centre 2

Canada Defence Scientific Information Service 1

NZ Defence Information Centre 1

National Library of Australia 1

UNIVERSITIES AND COLLEGES

Australian Defence Force Academy Library 1

Head of Aerospace and Mechanical Engineering, ADFA 1

Deakin University Library, Serials Section (M List), Deakin
University Library, Geelong, 3217 1

Senior Librarian, Hargrave Library, Monash University 1

Librarian, Flinders University 1

OTHER ORGANISATIONS

NASA (Canberra) 1

Australian Government Publishing Service 1

The State Library of South Australia 1

Parliamentary Library of South Australia 1

OUTSIDE AUSTRALIA**ABSTRACTING AND INFORMATION ORGANISATIONS**

INSPEC: Acquisitions Section Institution of Electrical Engineers 1

Library, Chemical Abstracts Reference Service 1

Engineering Societies Library, US 1

Materials Information, Cambridge Science Abstracts, US 1

Documents Librarian, The Center for Research Libraries, US	1
INFORMATION EXCHANGE AGREEMENT PARTNERS	
Acquisitions Unit, Science Reference and Information Service, UK	1
Library – Exchange Desk, National Institute of Standards and Technology, US	1
SPARES	
	5
Total number of copies:	66

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION DOCUMENT CONTROL DATA				1. CAVEAT/PRIVACY MARKING	
2. TITLE An Application of Checkland's Soft Systems Methodology to the Development of a Military Information Operations Capability for the Australian Defence Force			3. SECURITY CLASSIFICATION Document (U) Title (U) Abstract (U)		
4. AUTHOR(S) R. J. Staker			5. CORPORATE AUTHOR Electronics and Surveillance Research Laboratory PO Box 1500 Salisbury, South Australia, Australia 5108		
6a. DSTO NUMBER DSTO-TN-0183		6b. AR NUMBER AR-010-816		6c. TYPE OF REPORT Technical Note	
7. DOCUMENT DATE March, 1999					
8. FILE NUMBER N8316/21/1		9. TASK NUMBER JNT 96/229		10. SPONSOR DGISC	
11. No OF PAGES 24		12. No OF REFS 12			
13. DOWNGRADING / DELIMITING INSTRUCTIONS Not Applicable			14. RELEASE AUTHORITY Chief, Information Technology Division		
15. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT <i>Approved For Public Release</i> <small>OVERSEAS ENQUIRIES OUTSIDE STATED LIMITATIONS SHOULD BE REFERRED THROUGH DOCUMENT EXCHANGE CENTRE, DIS NETWORK OFFICE, DEPT OF DEFENCE, CAMPBELL PARK OFFICES, CANBERRA, ACT 2600</small>					
16. DELIBERATE ANNOUNCEMENT No Limitations					
17. CITATION IN OTHER DOCUMENTS No Limitations					
18. DEFTEST DESCRIPTORS Military Intelligence Information Management Information Warfare Soft Systems Methodology					
19. ABSTRACT There is widespread concern throughout many advanced nations concerning the potential for Information Operations to influence the outcome of Military Operations. This concern is shared by elements of the Australian Defence Force and other Australian government agencies. In order to ensure that any such potential does not adversely affect Australian interests, there is a need to develop an Australian Military Information Operations capability. This document uses concepts from Checkland's Soft Systems Methodology to explore methods through which such a capability could be achieved.					